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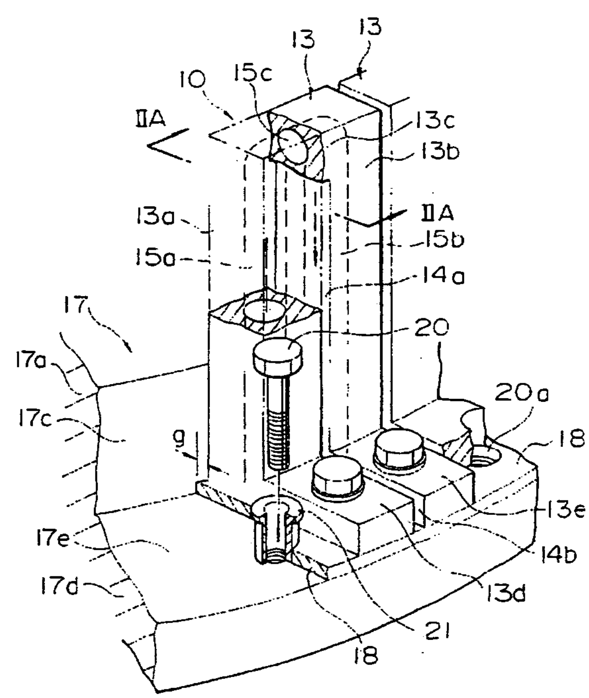
(54) Segmented cold-wall induction melting crucible.

(57) In a segmented water-cooled induction melting crucible mainly used for melting special metals such as reactive metals or alloys, two adjacent segments (13a,13b) are coupled as a unit paired segment (13) having two legs, the one leg is formed to have an inlet water passage and the other to have an outlet water passage, so that these water passages can form a one-way water flow path when they are connected (19). When the adjacent two legs are connected at their top portion to form a shorted portion, the lower end of the legs are insulated from each other and to a base forming a bottom of the crucible. Alternatively the two legs can be entirely separated by elongating the slit (14a) and the water passage formed in each leg can be conncted throgh an insulative connecting member (19). In either means the water passgein each leg can be reduced to the size same as the inner tube in each segment of the conventional crucible, and by virtue of this construction, both the radial thickness and the width of each segment can be reduced which enables to increase the number of segments in a crucible of the same inner space.

FIG. I



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The present invention relates to induction melting crucibles generally called as segmented cold wall induction melting crucible having construction suitable for melting metals and alloys called special metals mentiond below, and more particularly to improved crucible body construction including side wall and base portion.

The special metals referred to above can be classified into following three types, that is,

1) high purity metals and alloys known to be semiconductor materials,
2) reactive metals such as titanium, zirconium(Zr) and their alloys difficult to melt as high purity products due to their chemical properties of being liable to react with oxygen and nitrogen, and
3) metals having very high melting temperature such as tungsten(W), molybdenum(Mo), tantalum and niobium.

Heretofore, special metals and alloys referred to above have been melted using electron beam melting furnace, nonconsumable electrode arc furnace or the like, however these furnaces have revealed some problems in melting the above-mentioned high purity or reactive metals and alloys which are difficult to melt, for instance, with an electron beam melting furnace it is necessary to restrict its melting atmosphere to lower than 10^{-3} Torr, and thus induction melting techniques have been widely used in place of the electron-beam melting by virtue of the simple construction requested together with covenient ways of use.

Among various induction melting furnaces, cold wall induction melting (alternately referred to as cold-crucible induction melting,induction skull melting or the like) has been widely adopted as a melting method suitable for melting the aforesaid special metals and alloys.

A cold wall induction crucible which has generally been used heretofore, as typically shown in Figs.7 A and 7B, is a metal crucible used for induction melting comprising; a main crucible body 1 made of metals having good thermal and electrical conductivity mainly of copper and formed to have a shape generally of hollow cylinder with a bottom, the side wall of which or even the entire side wall and a part of the base portion are divided into a plurality of segments 3 by a plurality of slits 2 separating adjacent segments 3, and an induction heating coil 8 surrounding the crucible main 1, wherein interior of each segment 3 is cooled by a cooling medium such as water.

Next, explanation will be made hereunder on the process of melting the metallic material charged in the cold wall type induction melting crucible.

Metal or metals and or master alloys to be melted are charged into the crucible chamber in a state of lumps, granules, plate-like, powder mixtures thereof or the like .

Upon starting of induction melting, the charged materials start melting beginning from the outer surface thereof and the molten metal flows down toward the bottom of the crucible, where it solidifies as a skull of shallow dish-like configuration acting as a second metellurgical vessel holding thereon the molten metal and the charge not yet melted.

As the amount of molten metal increases due partly to stirring caused by the rather high frquency of the power than that supplied to ordinary induction melting process, the level of the molten metal rises and the skull formed around the inner surface of the segments also grows upward and forms a side wall of the skull upstanding integral with the dish-like bottom part and constitutes a metallurgical vessel alike a pan, which prevents molten metel from directly adhering to the side wall of the segments and entering into the slits and contains therein the increased amount of molten metal and the charge still remaining unmelted.

As melting further proceeds until the whole of the charge has melted down, the level of the molten metal also rises to constitute a molten pool of the charged metal.

Under this condition, central part 9a of the molten metal 9 along the vertical axis of the crucible body is raised upward, while the peripheral portion of the molten metal 9 is lowered along the side wall of the crucible to form a convexed curved surface as shown in Fig.7A, thereby the molten metal generally leans away from contact with the inner face of the segments 3, thereby preventing any adjacent water cooled segments 3 being electrically insulted from each other by respecvtive slits from being shorted by the molten metal.

Copper is selected as the material suitable for forming a crucible in place of a usual refractory material. By virtue of its high thermal and electrical conductivity, segments made of copper forming a side wall of the crucible when cooled by a suitable cooling medium such as water, can be held at a temperature considerably lower than that of the molten metal received therein.

Since the crucible is constructed as explained above, the crucible itself will never reach such a high temperature at which it reacts with the metal or metals to be melted so that undesirable chemical compounds are formed which would contaminate the molten metal as usually encountered in crucibles made of refractory material which are impossible to water cool.

Instead, since the substances to be melted are limited only to those materials charged into the crucible, inclusion of impurities can be avoided thereby giving rise to high purity products, moreover uniformity in the melting process also can be attained by virtue of a stirring action which is a feature of induction melting.

On the other hand, due to the high electrical conductivity there is such another problem that the cru-

cible itself is liable to be induction heated, but the possibity of the crucible being heated as a secondary coil with respect to a primary induction coil upto such a high temperature as mentiond above, can be avoided by splitting the crucible wall vertically into a plurality of segments each having therein a hollow cylindrical chamber into which a cooling medium such as water is introduced for cooling each segment.

However, it is still inevitable for the segments, due to their good electrical conductive properties, to be heated to some extent by the primary induction heating coil in a manner similar to the material to be melted.

Actual measurements have revealed that, if the amount of power used for melting the material charge is assumed to be one(1) the power used for heating the crucible was found 1.3, as a result it has been roughly estimated that only 40 % of the input power was utilised for melting charged material.

It is considered effective, as a measure for reducing the extent of heating for the water cooled segments themselves, to reduce the radial wall thickness of each segment, however, each water cooled segment of conventional type, as shown in Figs.7A and 7B, is a double tube construction having both an inlet passage and an outlet passage in a single segment, that is, cylindrical hollow tube 11 further receives therein an inner tube 11a, as a consequence there is a restriction for reducing the radial thickness of each segment in the radial direction.

On the other hand, the greater the number of segments disposed, the less becomes the chance that each segment is heated, and the magnetic flux density adjacent to the wall of the crucible becomes more uniform which contributes to stabilize the molten metal, however, there still remains the same restriction as mentioned above due to the restriction for reducing the wall thickness in the radial direction.

By taking the above-mentioned problems in the conventional segmented cold-wall induction melting crucible into account, an object of the the present invention is to provide a segmented cold wall crucible capable of reducing both the radial and circumferential wall thickness of each segment and of incresing the number of segments in a crucible as compared with the conventional crucible of the same size.

A further object of the present invention is to provide a segmented cold-wall induction melting crucible wherein attenuation of the applied power can be reduced by virtue of the novel structural features of the present invention.

1) According to preferred features of the present invention, the structure of each segment, as shown in Fig.8A, is composed generally of a pair of two adjacent segments 3A and 3B which are connected one after another to constitute a unit segment, and the segments 3A and 3B are connected integrally at their top portion to constitute a connected, namely a shorted portion 3C, the portion of the segment lower than the shorted portion 3C is separated by a slit 2A into the segments 3A and 3B.

The slit 2A has a height starting from the lower end of the shorted portion 3C down to the lower end of the segment.

Each segment, as shown in Fig. 8B, is formed to have an elongated upwardly directed hole, and the two holes in the unit segment are communicated through a passage formed in the shorted portion.

In this way, cooling water is introduced to the lower end of one hole and supplied to the upper end of the other hole via the passage in the shorted portion and then discharged from the bottom end of the other hole.

By virtue of this twin type segments, each segment has only to have a single small hole having an inner diameter almost the same as that of the inner tube 11a of the segmented cold-crucible of the conventional type, thereby both the width and the radial thickness of each segment can be reduced.

2) However, due to the fact that the two adjacent segments are connected at their top portion to constitute a unit segment, there would arise another problem of inducing a current circulating the two segments as a closed loop circuit as shown in Fig.8A, if the bottom of the unit segments having been connected at their top portion are connected to constitute an integral crucible base, or the bottom end of each segment separated by respective slits is simply connected to a conductive base member to form a crucible bottom.

A closed loop electric circut is established, in which current flows as follows;

left segment 3A→ upper shorted portion 3C→ right segment 3B → conductive base portion 4, and returning to left segment 3A, and therefore, when an induction coil is energized by a current flowing through the closed circuit, namely, the current C circulating around the the slit 2A is established and thereby a magnetic field generated by the current C attenuates the magnetic flux from the induction coil passing through the slit to enter into the metals to be melted in the the crucible.

In order to prevent the current circulating around the slit from forming, following measures have been taken:

a) An insulating member has been interposed between the lower end of the foot portion 5A of each leg portion 3A(3B) of each segment and the conductive base member 4, so that the lower end of the foot portion 5A can be elect-rically insulated from the base member.

b) As an alternative way, the slit is further extended beyond the connected portion, in other words, the two segments 3A and 3B themselves are not conected as an integral member, but they are placed upstanding side by side being spaced

apart by a slit and the respective water passages 11a and 11b are connected at their upper portion by a connecting member of insulating material, so that these two segments are insulated from each other for preventing them from forming paths of circulating current.

Based on the above-mentioned technical concept for solving the pending problems, the inventors of the present invention have filed a Japanese Patent Application entitled " Crucible Structure of a Cold-Wall type Melting Furnace" under date of October 16, 1991(Japanese Patent Application No.Hei 3-294848).

However, due to the provision of the connected portion according to the aforesaid aspect a), it was found later that some problems occured, particularly either in a massive columnar body of unexpectedly solidified charged metal due to abnormal events such as a stoppage of the electric current or other problems in the melting means, or in an ingot intentionally formed in the crucible, similar troubles are also encountered in the skull remaining in the crucible even after normal pouring of the molten metal from the crucible.

In more detail, the massive columnar body or ingot 5 is shaped as shown in Fig.9A, while the skull 5' remaining in the crucible is shaped as a hollow thin cylinder 5 having a protrusion 5b like a tongue on a part of the top end as shown in Fig.9B.

Both the massive columnar body or ingot 5 and the skull 5' have a number of somewhat linear and low raised portions 5a like mountain ridges, formed on the outer surface thereof and extending vertically along the vertical axis of the crucible.

These raised portions 5b in the former type are formed when the molten metal partly encroaches into the slits and solidifies in situ undesirably or intentionally, while the raised portions 5b of the skull of the latter type are formed in a similar manner even when the molten metal is poured through a pouring port of the crucible in a normal step of pouring.

If such raised portions have once formed, it becomes very difficult or even impossible to pull out the thus solidified matter outside the crucible, as a consequence, a crucible of the type is required to solve the problem.

The inventors of the present invention have solved the aforesaid problem by forming a vertically extending shallow groove on the inner surface of the connected portion of each paired segment, which groove is formed as the extension of the slit between two legs of the paired unit segment having a depth less than the radial thickness of the connected portion but sufficient to pass through the raised portion of the above-mentioned solidified matter.

According to the present invention, the segmented cold-wall crucible comprises, a plurality of unit segments each formed by joining two adajacent segments at their top portion as a connected or a shorted portion, but at the portion under this connected portion down to the lower end, each segment is separated from the other one by a slit and is formed therein a single hole as a water passage so that two of the single hole in each segments are connected by a communication passage formed in the connected portion to constitute a one-way water passage for flowing coolig water from the bottom of one segment to the bottom of the other segment via the communication passage, thereby the single hole formed in each segment has only to have an inner diameter almost equal to that of the inner tube formed in each segment of the conventional type having double tube structure, and thus both the thickness and the width of each tube can be made smaller and the power supplied to the melting unit can be remarkably reduced.

It is also possible to increase the number of segments to be arranged in a crucible, flux density adjacent to the side wall of the crucible becomes more uniform which enhances stability of the molten metal in the crucible.

The other objects and features of the present invention will become apparent from the following description with reference to the accompanying drawings., in which:

Fig. 1 is a fragmented perspective view showing a first embodiment of the present invention.

Fig. 2A is a schematic sectional side view of the half part of the segmented cold-wall crucible taken along B-B of Fig. 1.

Fig. 2B is a schematic sectional side view of the half part of the segmented cold-wall crucible shown in Fig. 2A and added with magnetic lines of force.

Fig. 3 is a perspective view showing a unit segment shown in Fig. 1.

Fig. 4A is a perspective view showing a unit segment of the second embodiment of the invention.

Fig. 4B is a perspective view showing a connecting member shown in Fig. 4A.

Fig. 5A is a fragmented perspective view showing a third embodiment of the present invention.

Fig. 5B is a fragmented perspective view in enlarged scale showing the groove shown in Fig.5A.

Fig. 6 is a schematic sectional side view of the half part of the segmented cold-wall crucible taken along VI-VI of Fig.5.A.

Fig. 7A is a side view of a conventional segmented cold-wall crucible.

Fig. 7B is a fragmented plan view of Fig. 7A.

Fig. 8A is a front view of a unit segment of the present invention having two separated legs joined at their top portion but having no insulation at the bottom showing a current flowing along the unit segment and a base portion.

Fig. 8B is a sectional side view cut by a vertical plane passing through both a slit and the vertical axis of the segment.

Fig. 9A is a schmatic perspective view showing a vertical raised portion on the outer surface of a solidified columnar body formed in the crucible.

Fig. 9B is a schmatic perspective view showing a vertical raised portion on the outer surface of a skull formed during the pouring.

Fig.1 is a partial perspective view showing a part thereof being sectioned to show a first embodiment of the invention, and Figs. 2(A) and 2(B) are reduced scale side views taken along B-B of Fig. 1.

Numeral 10 in the drawings shows an entire part of the cold wall induction melting crucible according to the present invention and numeral 13 designates a unit segment by joining two adjacent segments into a pair.

Each unit segment 13 consists of a left leg 13a and a right leg 13b in the drawing, and these two legs are joined at their top portion to constitute a shorted portion 13c, lower parts thereof are separated by a slit 14a to define the two legs 13a and 13b mentioned above, in each of which legs a hole 15a or a hole 15b is formed through the axially central part thereof from the bottom of each leg and upto the joined portion and each of the two holes is used either as an inlet hole or an outlet hole for a passage for cooling water when these two holes are connected by a communication hole 15c opened almost horizontally through the joined portion 13c.

Fig.3 shows a practical structure for fluid-tightly connecting the inlet hole 15a and the outlet hole 15b.

Each of these inlet hole 15a and the outlet hole 15b is formed, respectively, by upwardly drilling respective leg 13a and 13b from their bottom end upto the place slightly lower than the upper end of the communication hole 15c is to be opened, then the communication hole 15c is drilled horizontally from both opposite outer ends of the legs 13a and 13b so that these two holes can reach and pass through the upper part of each hole and meet with each other and constitute a single communication hole 15c, the outermost open ends of which are fixed, spectively, with a closure member 19 and is sealed by an O ring in a water tight manner.

Respective lower end of leg 13a and 13b is formed to have an integrally affixed and radially and outwardly extending foot 13d or 13e. A slit 14 is defined between the two foot 13d and 13e communicating with the slit 14b between the legs 13a and 13b. When whole unit segment is assembled, the feet 13d and 13e constute flanges intermittently disposed at the lower end of the side wall of the crucible, thereby these flanges are placed on an annular flange of the base 17 as a bottom of the crucible 17 as explained later in more detail.

In Fig.1, numeral 17 is a base fabricated of electrically conductive material to constituite the bottom of the crucible and 17a is a central raised portion to form the bottom of the when inserted to the interior space defined by the side wall of the crucible which can be formed by intermittently disposedinner face of respective pair of legs when all the unit segments are assembled together, thereby the bottom and the inner face constitute a crucible chamber.

17d denotes an annular flange extending radially outward from the lower end of the raised portion 17a and acts as a flange of the entire crucible 10, onto which flange 17d the intermittently disposed flanges composed of the lower part of the legs and feet of unit segaments are laid so as to be supported by the flange.

An annular gap g of a specified distance is held between the inner face of the unit segments 13 and the outer face 17c of the raised portion 17a of the base 17 in order to reduce the possible chance where any shorting occuring between adjacent legs across the slit through molten metal inclusive of the skull entering into the slit.

Numeral 18 is an annular insulator plate fabricated of insulating material such as glass or laminated epoxy sheets, through which a specified number of bolt holes are opened.

The insulator plate thus formed is fitted around the outer face 17c of the raised portion 17a so as to be placed on the upper face 17e of the flange 17d, onto which feet 13d and 13e of each unit segment 13 is disposed, then bots 20 are passed through the feet 13d and 13e and the insulator plate 18 placed thereunder and then tightened to the screw hole(not shown) formed on the upper face 17e of the flange 17d.

This means of insulation is done with the intention to prevent the two adjacent lower faces of the feet 13d and 13e including the lower ends of legs shorting through the upper face 17e. Each bolt 20 is also insulated from the foot 13d or 13e by a T-shaped collar 21 made of a good insulator, so as to prevent an elecric circuit from being closed across the lower end of the slit 14 due to shorting between the flange 17d of the base 17 and any foot of the unit segment 13 through the bolt 20.

The operation of the first embodiment of this invention will be explained hereunder.

By supplying an alternating current of specified frequency to an induction heating coil 8, magnetic flux Φ flows around the coil 8 as shown in Fig. 2B.

Magnetic lines of force slightly vary depend on the section cut by a plane passing a specific point on the circle encompassing the segment 13 and the vertical axis of the crucible.

Fig.2B is a side view showing the magnetic lines of force sectioned at a plane in the slit 14a between the two legs 13a and 13b of a paired unit segment 13.

Since each unit segment 13 is composed of slim legs 13a and 13b, magnetic flux density formed adjacent to the inner face of the unit segment 13 becomes more uniform as compared with that formed

in any conventional type segment.

Charged material to be melted is heated by the current I induced by the aforesaid magnetic flux Φ and is melted and forms a pool of molten metal which, due to the electro-magetic interaction between the magnetic flux Φ and the current I and to the acceleration due to gravity G, is stirred in the crucible. As a consequence, the central part of the molten metal is raised, while the outer peripheral portion along the inner face of the crucible is lowered to form a convexed surface.

The molten metal at the portion contacting the bottom 17a and the water cooled side wall of the segment 13 solidifies to form a thin skin called a "skull" 5.

The current induced by the induction heating coil 8 which would flow circulating around the outer surface of the crucible main body will never flow, since it is interrupted by the slit 14 defined between the foot 13a and 13b of the unit segment 13.

Similarly, the current which would flow through a circuit in the order,

left segment 13a→ upper shorted portion 13c→ right segment 13b→ base portion 17,

also will never flow, since thereis provided the insulating member 18.

As melting further proceeds, the temperature of the segments 13 themselves also rises due to thermal radiation and by heat conduction given by the molten mass and by the partial induction heating inside the segments, but this temperature rise can be reduced to acceptable extent by increasing the flow rate of the cooling water.

Second Embodiment

Fig. 4A is a perspective view showing second embodiment of the present invention, in which numeral 13A is a unit segment according to this invention, which differs from the first embodiment with respect to the feature that a slit 14A is further extended upward beyond the upper end extremity of the segment so that left leg 13f can be entirely separated from the right leg 13g.

The upper ends of an inlet hole 15a and 15b are opened to the portion slightly below the top end of respective legs 13f and 13g as in the first Embodiment, and the two water passages are connected by a connecting member 19 interposed at its middle portion by an insulating member 19a shown in Fig.4(B).

Since neither of the legs 13f and 13g constitute any part of the path of electric current by virtue of the insulation by the connecting member 19, it is not required to insulate the two lower faces of the unit segment 13A from the flange 17d of thebase 17, however, if the connecting member 19 is fabricated merely of conductive metal or alloys, aforesaid mating members are required to be insulated as done in the first embodiment.

The manner of melting taking place in the crucible according to the present invention is quite a similar one to that in the first invention, so explanation thereof will not be repeated.

The aspect of the second embodiment differing from that of the first embodiment, resides in that the current induced by the induction heating coil 8, which otherwise would flow following the path,

left leg 13f→ connecting member 19→ right leg 13g→ base 17, will never flow by virtue of the insulating member 19a constituting the connecting member 19.

Third Embodiment

Fig. 5A is a perspective view showing a third embodiment of the present invention, and Fig. 5B is a partial perspective view in enlarged scale showing a groove formed as an extension of the slit in the previously explained embodiments.

A shallow groove 14c is formed additionally on the inner surface of the shorted portion 13c of each unit segment 13B as a partial extension of the slit 14 and having, a circumferential width the same as that of the slit 14, a depth exceeding the expectable maximum height of the raised portion 5a on the outer surface of an ingot 5 or a skull 5' and a vertical length sufficient to reach the top end of the unit segment, where it partly separates the unit segment 13B.

Referring again to Figs. 9A and 9B, the irregularly shaped raised portions 5a are formed vertically being spaced apart at an equal pitch in the circumferential direction due to their manner of formation, that is, they are formed by the molten metal in the crucible having encroached into the uniformly spaced slits in the unit segments as already explained.

In view of the nature of the raised portion 5b as explained above, it will be readily understood that, such undesirable solidified metal body, ingot or skull having such raised portions can be pulled out outside the crucible by passing the raised portions 5a through the groove 14c.

The construction and function other than the provision of additionally formed grooves 14c, is the same as the first and the second embodiment as already mentioned, so further explanation will not be repeated.

A key feature of the present invention resides in that the segmented cold-wall crucible comprises a plurality of unit segments each formed by joining two adjacent segments at their top portion as a connected portion or a shorted portion, but at the portion under this connnetd(shorted) portion down to the lower end, each segment is separated from the other one by a slit, and therin is formed a single hole as a water pas-sage so that the single hole in each of the segments are connected by a communication passage

formed in the shorted portion to constitute a one-way water flow passage for flowing cooling water from the bottom of one segment to the bottom of the other segment via the communication passage, thereby the single hole formed in each segment has only to have an inner diameter almost equal to that of the slender inner tube formed in each segment of the conventional type of double tube structure, and thus both the thickness and the width of each tube can be made smaller and the power supplied to the melting unit can also be remarkably rduced.

Another feature of this invention is that it is possible to increase the number of segments to be arranged in a crucible, magnetic flux density adjacent to the side wall of the crucible becomes more uniform which enhances stability of the molten metal in the crucible.

Yet another feature of this invention is the substantial amount of insulation applied to various portions of the crucible due to following reasons,

firstly. a suitable gap is maintained between the inner face of each unit segment and the outer surface of the central raised portion of the base,

secondly, the bottom face of the flanges formed by the paired legs of each unit segment is insulated from the upper face the flange of the base,

thirdly, when the paired legs of each unit segments are entirely separated by extending the slit beyond the shorted top portion, water passage from one leg to another leg is communicated through a connecting piece interposed by an insulating member.

By means of these insulation, undesirable current circulating the unit segment and / or other related member(s) can be avoided but it still allows magnetic flux generated by an induction heating coil to pass under the slit formed between two legs of the paired unit segment.

Furthermore, in the crucible of the type of the first embodiment using unit segments each having two legs combined and shorted at their top, molten metal may solidify as either one of following types, a solidified massive block due to stoppage of power, an intentionally formed ingot or the like in a crucible or a skull formed at the pouring port during normal pouring, which accompanying a number of low raised portions like ridges of mountains randomly formed by the molten metal having encroached in the slits and solidified in situ, and thus prevent ready pulling out of these solidified matter outside the crucible.

However, these problems can be solved by passing the raised portions through the vertically formed grooves on the inner face of the shorted top portion of the unit segment.

Claims

1. A segmented cold-wall induction melting crucible, comprising; a crucible main body composed of a side wall defined by a plurality of intermittently upstanding segments arrayed and being spaced apart from each other in circumferential direction to define a slit of specified width between adacent segments each being fabricated of good electrical conductive material, a base made of good electrical conductive material and inserted in a space defined by said intermittently upstanding segments and constitutes a crucible base being contiguous with said side wall, and an induction heating coil disposed around the outer face of said crucible proper, whierein:

   said plurality of segments form a plurality of paired unit segments each being spaced apart from each other at a specified gap and is composed of two adjacent legs being spaced apart at a spacified gap the same as that between said two adjacent unit segments, and each leg is formed to have a contiguously formed foot upstanding side by side, one of said leg being formed to have an inlet water passage and the other leg to have an outlet water passage so that these two passages when connected constitute a one-way flow passage of cooling water and each one of said pair of feet is extended radially outward from each leg to constitute a "L" shaped leg member as a whole;

   said base comprises, a raised central portion inserted in said central inner space defined by said side wall, and an annular flange extending radially outward from the lower part of said raised central portion for supporting said flanges of said plurality of unit segments laid thereon and fixed to the flange of said base,

   either the leg with a foot of one side of each unit segment is insulated from those of the other side, or the flange of said base is insulated from each of saidpaired unit segment.

2. A segmented cold-wall induction melting crucible as claimed in claim 1, wherein each of said unit segment is composed of two adjacent legs each having a foot and being separated from each other by a slit and upstanding, from the bottom where said legs are laid on and fixed to said base through at least an insulating member and to their top portion connecting both legs to constitute an electrically shorted portion, where said inlet passage and outlet passage are communicated together to from a one-way water passage.

3. A segmented cold-wall induction melting crucible as claimed in claim 2, wherein each foot of said unit segments is laid on said flange of said base member through at least an insulating plate or sheet(s) and fixed to said base by at least a bolt being surrounded by a collar fabricated of insulat-

ing material so that said flange of each unit segment can be insulated from the flange of said base.

4. A segmented cold-wall induction melting crucible as claimed in claim 1, wherein each of said unit segment is entirely separated into two legs without having shorted top portion and said water inlet passage and said water outlet passage in each leg are connected for enabling communication of cooling water from one passage to the other passage by a conncting member at least the central part thereof being insulated.

5. A segmented cold-wall induction melting crucible as claimed in claim 1, wherein each of said unit segment is entirely separated into two legs without having shorted top portion and said water inlet passage and said water outlet passage in each leg are connected for enabling communication of cooling water from one to the other passage by a conncting member fabricated of conductive material, and each of said two legs with a pair of feet of said unit segments are fixed to said base through at least an insulating member.

6. A segmented cold-wall induction melting crucible as claimed in claims 2 or 3, wherein each of said unit segment is separated by a slit into two legs with respective foot from the bottom upto the half way of the top portion being connected together as a shorted portion, where the shorted portion is formed to have a shallow through groove on the inner face of said shorted portion and extending vertically from the top end of said slit to the upper end extremity of said shorted portion and having a width at least the same as that of each slit and a depth larger than the expectable height of ridge like raised portions which have been formed along said slits and on the outer surface of a solidified body of charged metal(s) or alloy(s) formed either as a massive body in said crucible due to problems such as a stoppage of the electric current or the like, or by intentiotional solidification or as a thin ring shaped skull remained after pouring due to the fact that said skull and or said charged metal have encroached into and solidified in situ, so that these solidified body can be pulled out outside said crucible by passing said raised portions through said through grooves co-corresponding to said raised portions.

FIG. 1

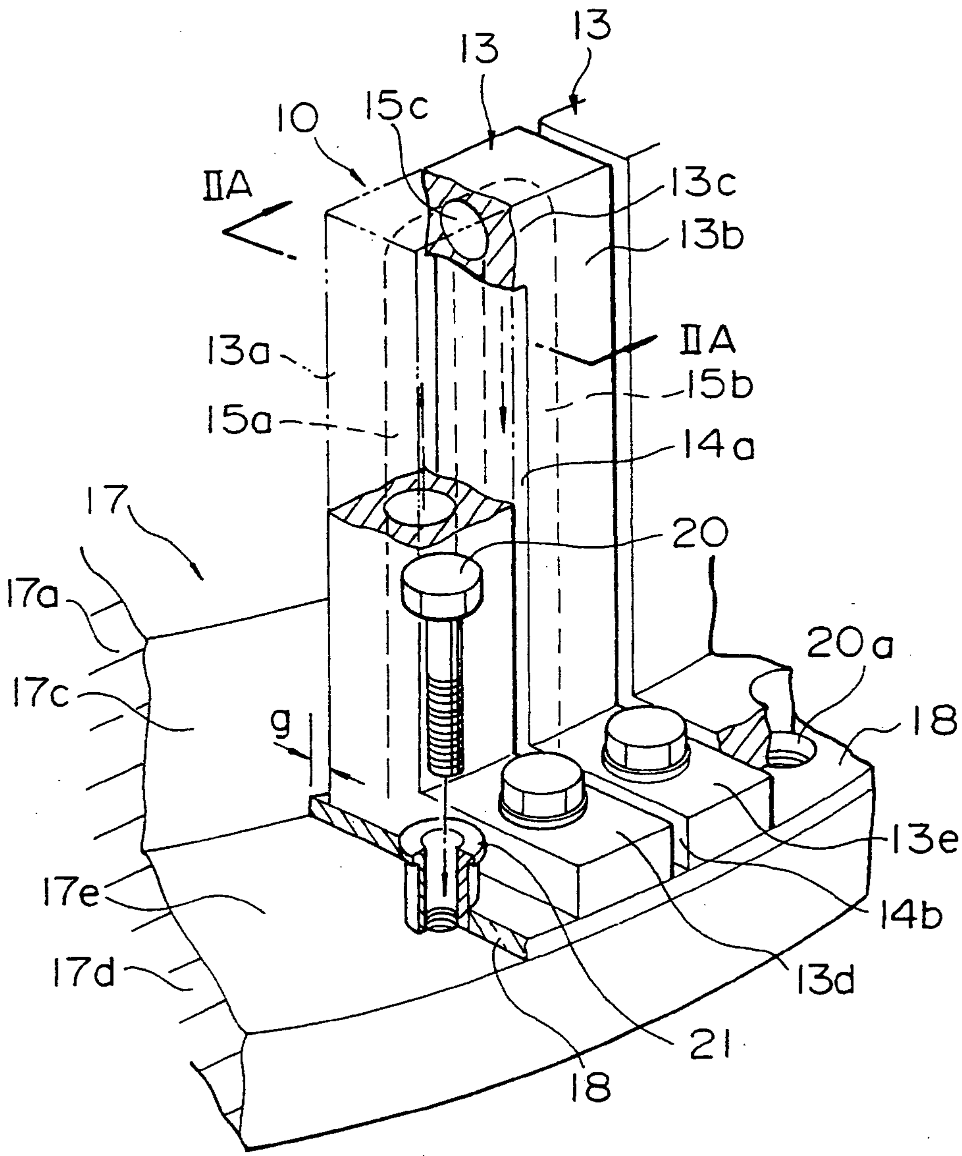

13
13
10
15c
IIA
13c
13b
13a
IIA
15b
15a
14a
17
20
17a
20a
17c
g
18
13e
17e
14b
17d
13d
21
18

FIG. 2A

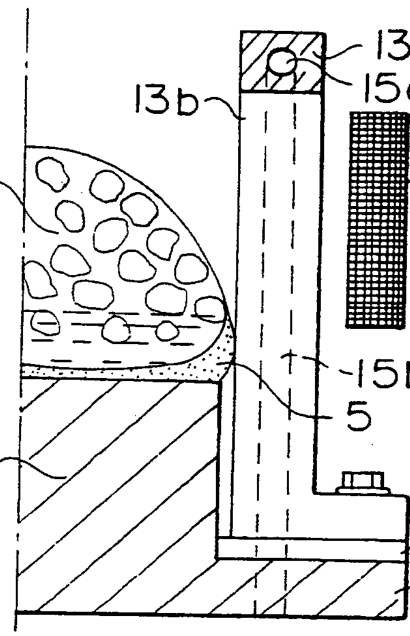

13c
15c
13b
9
8
15b
5
17a
18
17d

FIG. 2B

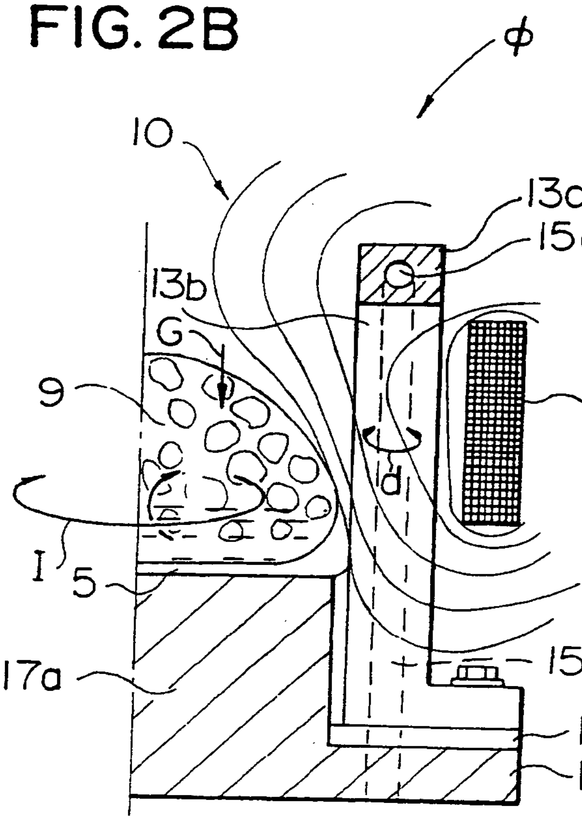

φ
10
13c
15c
13b
G
9
8
d
I
5
17a
15b
18
17d

FIG. 3

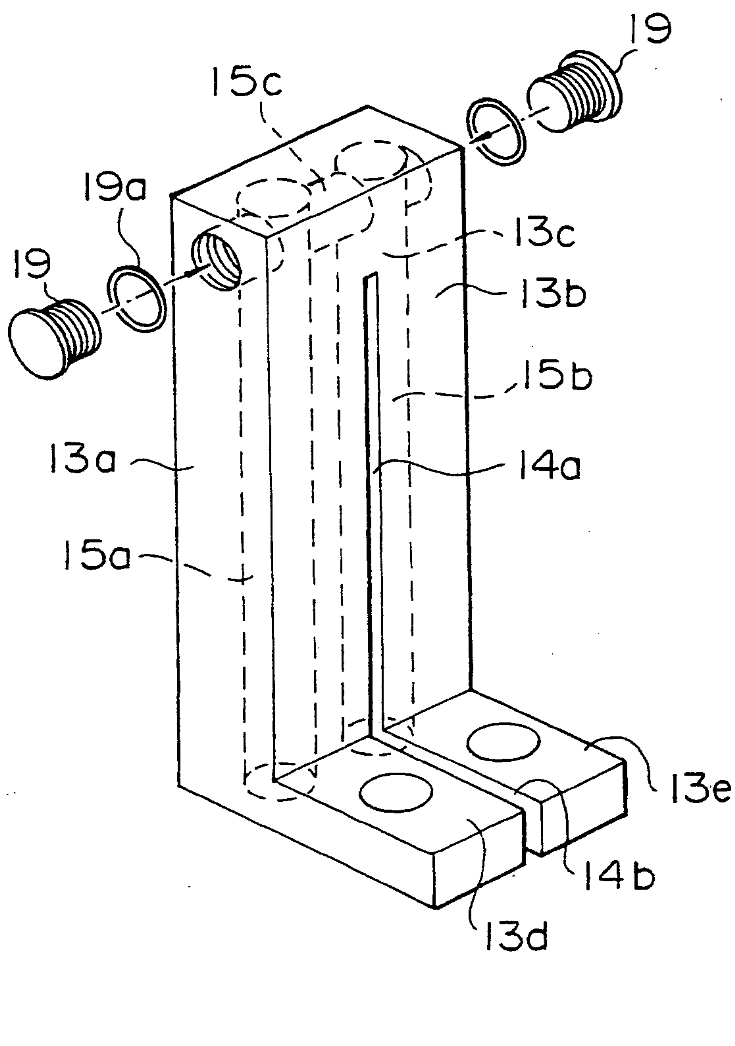


FIG.4A

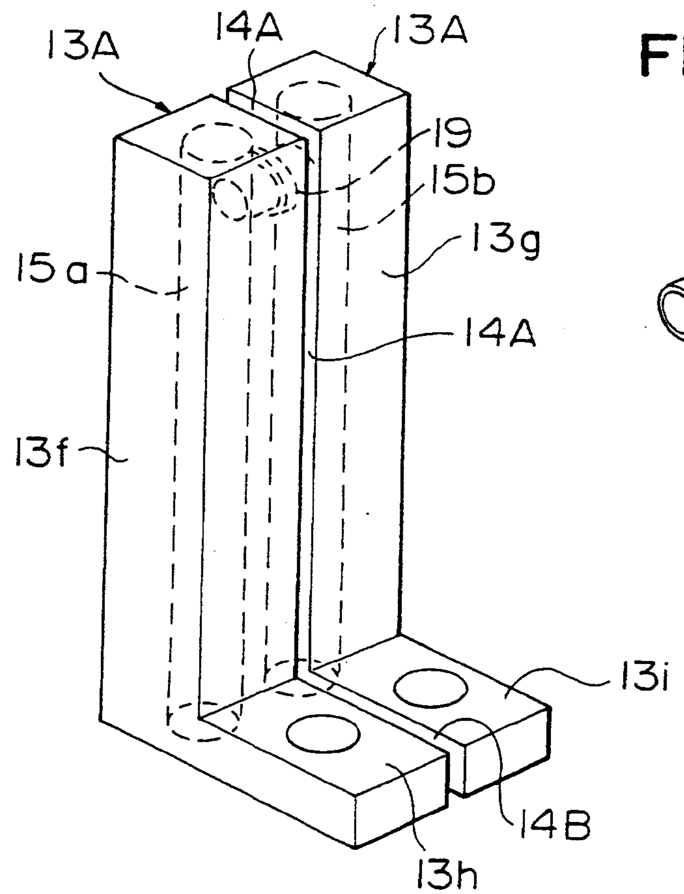


FIG.4B

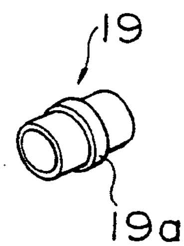


FIG.5B

FIG.5A

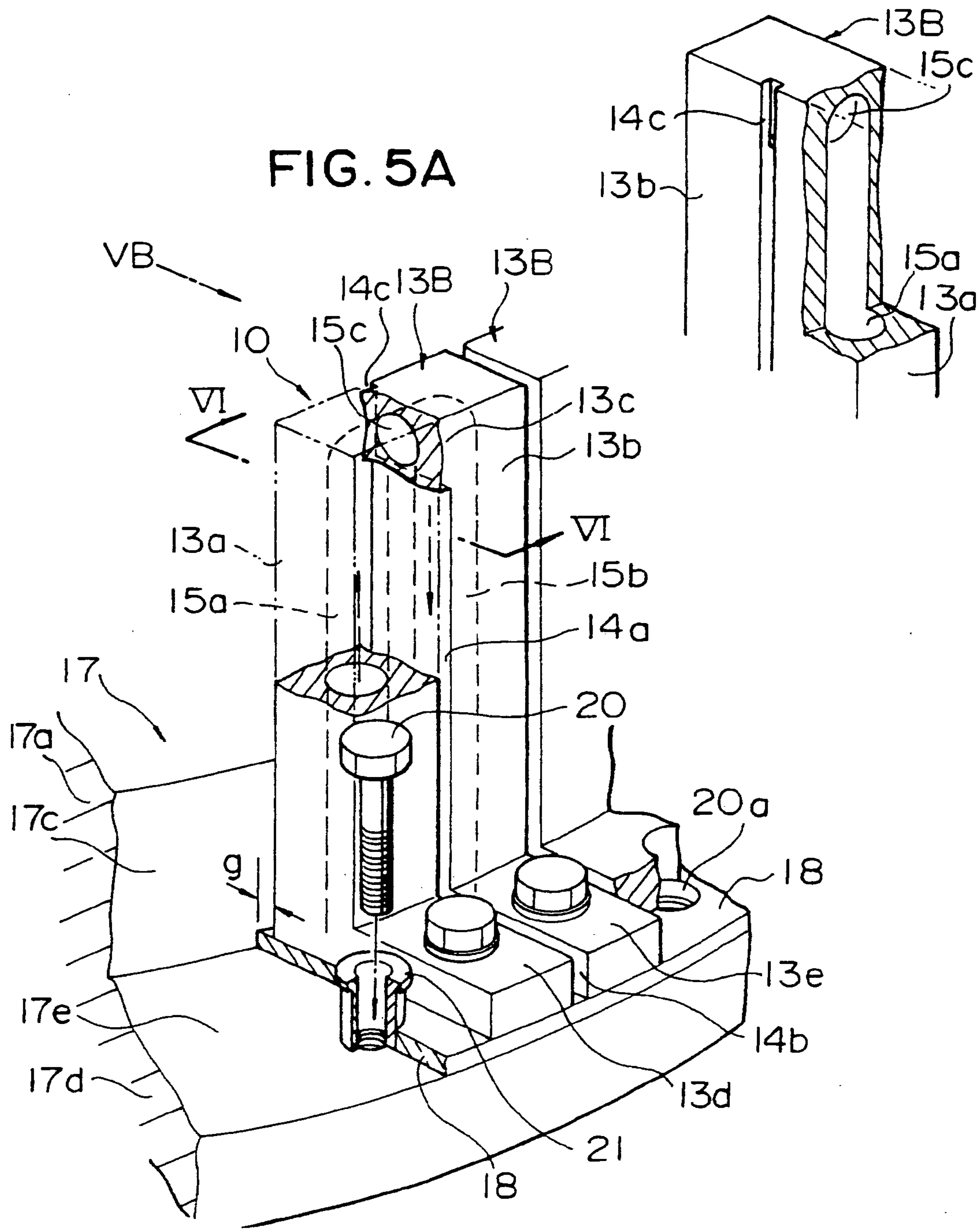

13B
15c
14c
13b
15a
13a
VB
14c
13B
13B
10
15c
VI
13c
13b
VI
13a
15b
15a
14a
17
20
17a
20a
17c
18
g
13e
17e
14b
17d
13d
21
18

FIG.6

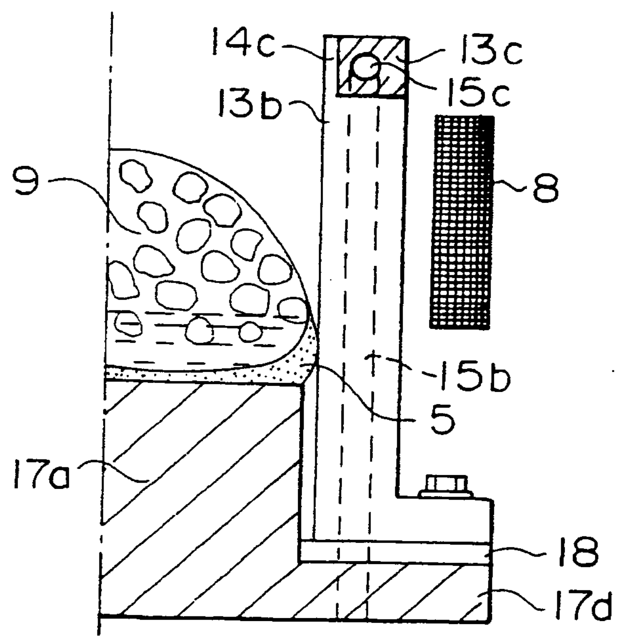


FIG. 7A

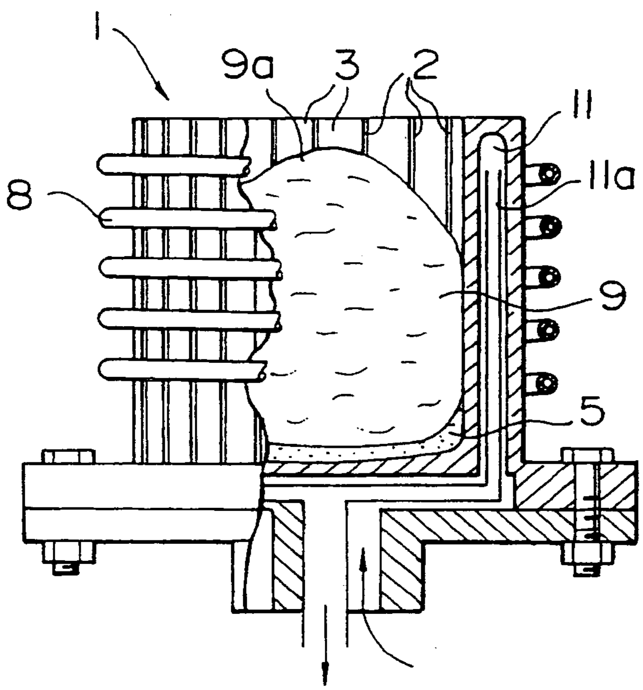


FIG. 7B

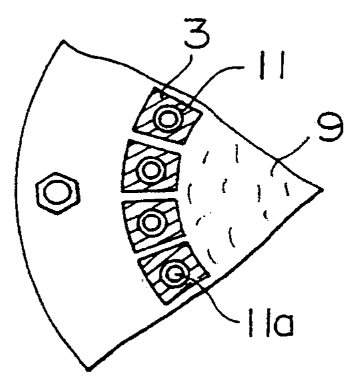


FIG. 8A

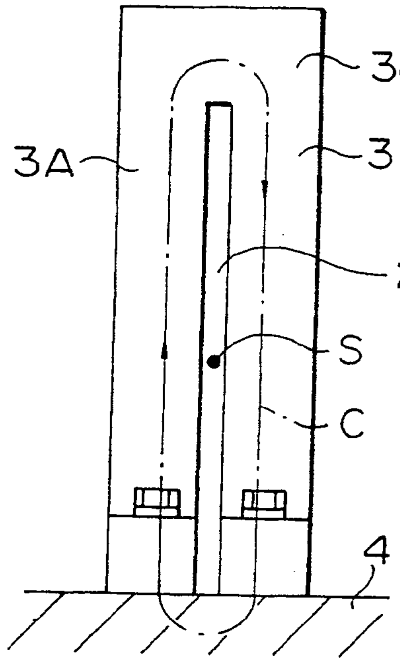


FIG. 8B

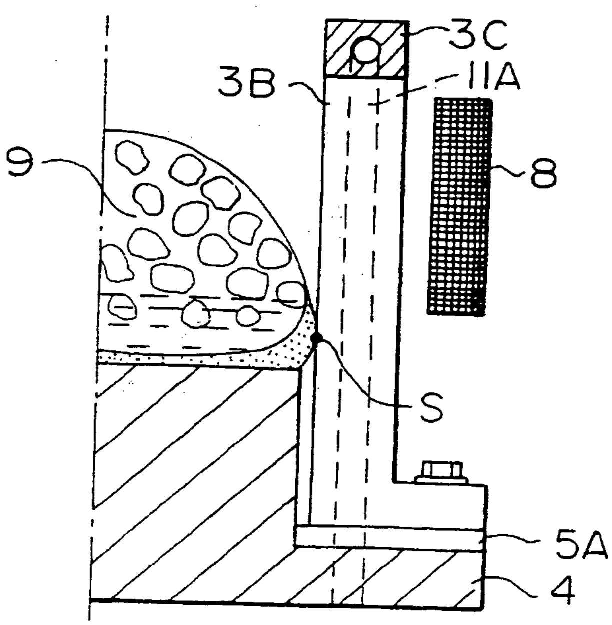


FIG. 9A

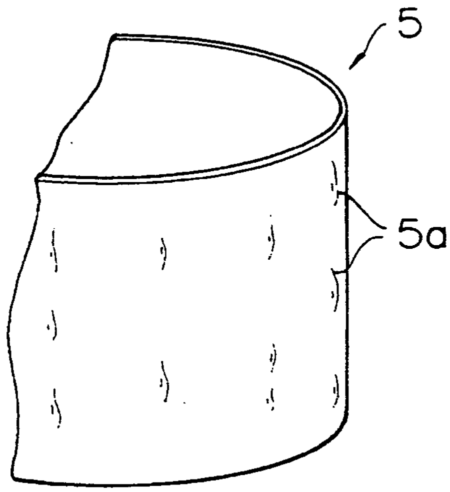
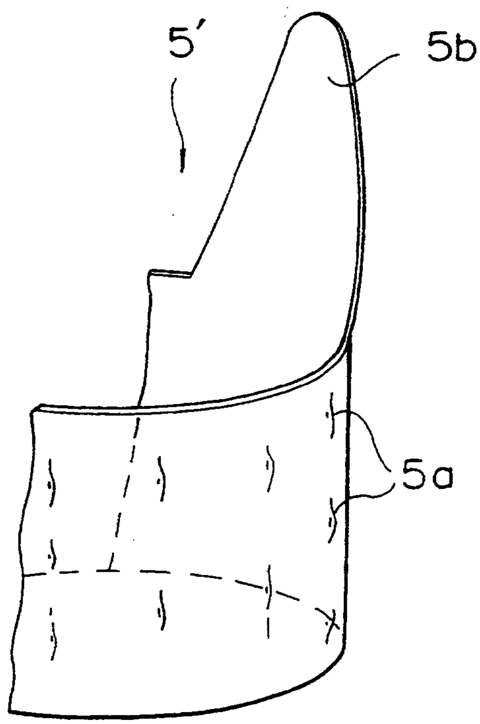


FIG. 9B



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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 9393

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 056 915 (SAPHYMO-STEL) * page 9; figure 2 *	1	F27B14/10
X	GB-A-1 221 909 (STANDARD TELEPHONES AND CABLE LTD) * page 2, line 53 - line 70; figure 3 *	1	
Y	EP-A-0 391 067 (LEYBOLD AG) * page 4, line 44 - line 53; claims 10-11; figures 2A,2B *	1	
Y	CH-A-494 939 (INT STANDARD ELECTRIC CORP) * claims 1-5; figures *	1	
A	US-A-4 923 508 (R.S.DIEHM) * column 3 - column 4; figures 1,2 *	2,3	
A	US-A-4 738 713 (D.R.STICKLE) * claims 1-7; figures *	1-3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F27B
H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02 DECEMBER 1992	COULOMB J.C.

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